

CLAIMS

I/We claim:

[c1] 1. A system for depositing material onto a microfeature workpiece in a reaction chamber, the system comprising:
a gas supply assembly having a first gas source for containing a first gas;
a first gas conduit coupled to the first gas source;
a first valve assembly including first and second valves in fluid communication with the first gas conduit, the first and second valves configured in a parallel arrangement so that the first gas flows through the first valve and/or the second valve;
a reaction chamber; and
a gas distributor carried by the reaction chamber and in fluid communication with the first valve assembly.

[c2] 2. The system of claim 1, further comprising a controller configured to operate the first and second valves in an alternating sequence.

[c3] 3. The system of claim 1, further comprising a controller configured to operate the first and second valves at least partially simultaneously.

[c4] 4. The system of claim 1 wherein the first valve assembly further comprises first and second gas passageways in fluid communication with the first gas conduit, the first valve being configured to control the first gas flow through the first passageway, and the second valve being configured to control the first gas flow through the second passageway.

[c5] 5. The system of claim 1 wherein the first valve assembly further comprises a third valve in fluid communication with the first gas conduit, the first,

second, and third valves being arranged symmetrically so that the first, second, and third valves are spaced apart from a portion of the gas distributor by at least approximately the same distance.

[c6] 6. The system of claim 1 wherein the gas supply assembly further comprises a second gas source for containing a second gas, and wherein the system further comprises:

- a second gas conduit coupled to the second gas source and in fluid communication with the gas distributor; and
- a second valve assembly including third and fourth valves in fluid communication with the second gas conduit, the third and fourth valves being configured in a parallel arrangement so that the second gas flows through the third valve and/or the fourth valve.

[c7] 7. A system for depositing material onto a microfeature workpiece in a reaction chamber, the system comprising:

- a gas supply assembly having a first gas source containing a first gas;
- a first gas conduit coupled to the first gas source;
- a first valve and a second valve each in fluid communication with the first gas conduit, the first and second valves being operable independently to individually and/or jointly provide pulses of the first gas downstream from the first and second valves;
- a reaction chamber; and
- a gas distributor carried by the reaction chamber and in fluid communication with the first and second valves to receive the pulses of the first gas.

[c8] 8. The system of claim 7, further comprising a controller configured to operate the first and second valves in an alternating sequence.

[c9] 9. The system of claim 7, further comprising a controller configured to operate the first and second valves simultaneously.

[c10] 10. The system of claim 7, further comprising first and second gas passageways coupled to the first gas conduit, the first valve configured to control the first gas flow through the first passageway, and the second valve configured to control the first gas flow through the second passageway.

[c11] 11. The system of claim 7, further comprising a third valve in fluid communication with the first gas conduit, the first, second, and third valves being arranged symmetrically so that the first, second, and third valves are spaced apart from a portion of the gas distributor by at least approximately the same distance.

[c12] 12. The system of claim 7 wherein the gas supply assembly further comprises a second gas source for containing a second gas, and wherein the system further comprises:

a second gas conduit coupled to the second gas source and in fluid communication with the gas distributor; and

a third valve and a fourth valve each in fluid communication with the second gas conduit, the third and fourth valves being operable independently to individually and/or jointly provide pulses of the second gas downstream from the third and fourth valves.

[c13] 13. A system for depositing material onto a microfeature workpiece in a reaction chamber, the system comprising:

a gas supply assembly having a first gas source for providing a first gas;

a first gas conduit coupled to the first gas source to carry the first gas from the first gas source;

a valve assembly including a body with first and second gas passageways in fluid communication with the first gas conduit, a first valve stem

configured to control the flow of the first gas through the first gas passageway, and a second valve stem configured to control the flow of the first gas through the second gas passageway, the first and second gas passageways configured in a parallel arrangement; a reaction chamber; and a gas distributor carried by the reaction chamber and in fluid communication with the first gas conduit.

[c14] 14. The system of claim 13, further comprising a controller configured to operate the first and second valve stems in an alternating sequence.

[c15] 15. The system of claim 13, further comprising a controller configured to operate the first and second valve stems simultaneously.

[c16] 16. The system of claim 13 wherein:
the body of the valve assembly further comprises a third gas passageway in fluid communication with the first gas conduit; and
the valve assembly further comprises a third valve stem configured to control the flow of the first gas through the third gas passageway.

[c17] 17. The system of claim 13 wherein:
the valve assembly comprises a first valve assembly;
the body comprises a first body;
the gas supply assembly further comprises a second gas source for providing a second gas; and
the system further comprises –
a second gas conduit coupled to the second gas source and in fluid communication with the gas distributor; and
a second valve assembly including a second body having third and fourth gas passageways in fluid communication with the

second gas conduit, a third valve stem configured to control the flow of the second gas through the third gas passageway, and a fourth valve stem configured to control the flow of the second gas through the fourth gas passageway, the third and fourth gas passageways configured in a parallel arrangement.

[c18] 18. A method of depositing material onto a microfeature workpiece in a reaction chamber, the method comprising:

flowing a first pulse of a first gas through a first gas conduit and a first valve into the reaction chamber; and

flowing a second pulse of the first gas through the first gas conduit and a second valve into the reaction chamber without flowing the second pulse of the first gas through the first valve.

[c19] 19. The method of claim 18 wherein flowing the second pulse of the first gas occurs after flowing the first pulse of the first gas.

[c20] 20. The method of claim 18 wherein the procedures of flowing the first pulse of the first gas and flowing the second pulse of the first gas are repeated sequentially.

[c21] 21. The method of claim 18 wherein the procedures of flowing the first pulse and flowing the second pulse occur at least partially simultaneously.

[c22] 22. The method of claim 18 wherein:

flowing the first pulse of the first gas comprises controlling the first valve to dispense the first pulse of the first gas into the reaction chamber; and

flowing the second pulse of the first gas comprises controlling the second valve to dispense the second pulse of the first gas into the reaction chamber.

[c23] 23. The method of claim 18 wherein:
the first and second valves are configured in a parallel arrangement; and
flowing the first and second pulses of the first gas comprise flowing the first and second pulses of the first gas through the first and second valves configured in the parallel arrangement.

[c24] 24. The method of claim 18 wherein:
the first and second valves are part of a valve assembly;
flowing the first pulse of the first gas through the first valve comprises flowing the first pulse of the first gas through the valve assembly;
and
flowing the second pulse of the first gas through the second valve comprises flowing the second pulse of the first gas through the valve assembly.

[c25] 25. The method of claim 18 wherein:
flowing the first pulse of the first gas comprises flowing the first pulse of the first gas through a first gas passageway; and
flowing the second pulse of the first gas comprises flowing the second pulse of the first gas through a second gas passageway, the first and second gas passageways being configured in a parallel arrangement.

[c26] 26. The method of claim 18, further comprising flowing a third pulse of the first gas through the first gas conduit and a third valve into the reaction chamber.

[c27] 27. The method of claim 18, further comprising:
flowing a first pulse of a second gas through a second gas conduit and a
third valve into the reaction chamber; and
flowing a second pulse of the second gas through the second gas conduit
and a fourth valve into the reaction chamber without flowing the
second pulse of the second gas through the third valve.

[c28] 28. A method of depositing material onto a microfeature workpiece in a
reaction chamber, the method comprising:
controlling a first valve to provide a first pulse of a first gas to the reaction
chamber through a first gas line independent of a second valve; and
controlling the second valve to provide a second pulse of the first gas to
the reaction chamber through the first gas line independent of the
first valve.

[c29] 29. The method of claim 28 wherein:
controlling the first valve comprises dispensing the first pulse of the first
gas into the reaction chamber; and
controlling the second valve comprises dispensing the second pulse of the
first gas into the reaction chamber after dispensing the first pulse.

[c30] 30. The method of claim 28 wherein:
controlling the first valve comprises flowing the first pulse of the first gas
through a first gas passageway;
controlling the second valve comprises flowing the second pulse of the first
gas through a second gas passageway, the first and second gas
passageways being configured in a parallel arrangement.

[c31] 31. The method of claim 28 wherein:
the first and second valves are part of a valve assembly;

controlling the first valve comprises controlling the first valve of the valve assembly; and

controlling the second valve comprises controlling the second valve of the valve assembly.

[c32]

32. The method of claim 28, further comprising:

controlling a third valve to provide a first pulse of a second gas to the reaction chamber through a second gas line; and

controlling a fourth valve to provide a second pulse of the second gas to the reaction chamber through the second gas line independent of the third valve.

[c33]

33. A method for depositing material onto a microfeature workpiece in a reaction chamber, the method comprising:

flowing a first pulse of a first gas through a first gas passageway in a valve assembly coupled to the reaction chamber; and

flowing a second pulse of the first gas through a second gas passageway in the valve assembly, wherein the first and second gas passageways are configured in a parallel arrangement and are in fluid communication with a first gas conduit.

[c34]

34. The method of claim 33 wherein:

flowing the first pulse of the first gas comprises controlling the flow of the first gas through the first passageway with a first valve stem; and

flowing the second pulse of the first gas comprises controlling the flow of the first gas through the second passageway with a second valve stem.

[c35] 35. The method of claim 33, further comprising:
flowing a third pulse of the first gas through a third gas passageway in the valve assembly; and
flowing a fourth pulse of the first gas through a fourth gas passageway in the valve assembly, wherein the third and fourth gas passageways are configured in a parallel arrangement with the first and second gas passageways and are in fluid communication with the first gas conduit.

[c36] 36. A method for depositing material onto a microfeature workpiece in a reaction chamber, the method comprising:
opening a first valve to dispense a first pulse of a first gas into the reaction chamber through a first downstream main line;
closing the first valve;
opening a second valve to dispense a second pulse of the first gas into the reaction chamber through the first downstream main line; and
closing the second valve, wherein the first pulse of the first gas does not pass through the second valve and the second pulse of the first gas does not pass through the first valve.

[c37] 37. The method of claim 36, further comprising:
opening a third valve to dispense a first pulse of a second gas into the reaction chamber through a second downstream main line;
closing the third valve;
opening a fourth valve to dispense a second pulse of the second gas into the reaction chamber through the second downstream main line; and
closing the fourth valve, wherein the first pulse of the second gas does not pass through the fourth valve and the second pulse of the second gas does not pass through the third valve.

[c38] 38. The method of claim 36 wherein closing the first valve occurs before opening the second valve.

[c39] 39. The method of claim 36, further comprising:
opening a third valve to dispense a third pulse of the first gas into the reaction chamber through the first downstream main line after closing the second valve; and
closing the third valve.